English Translation of JP3-236130

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SPECIFICATION

1. TITLE OF THE INVENTION

Alloy Type Thermal Fuse

2. CLAIM

An alloy type thermal fuse characterized by using as a fuse element an alloy comprising metal of one, or two or more kinds selected from the group consisting of Cu, Sb, Bi, Cd, In and Ag, except for components of corresponding low-melting alloys, added by 1% by weight or less to one of low-melting alloys of (I) Sn: 61 to 65% by weight and Pb: 35 to 39% by weight, (II) Sn: 16 to 20% by weight, Pb: 30 to 34% by weight, and Bi: 48 to 52% by weight, (III) Sn: 46 to 50% by weight, Pb: 13 to 19% by weight, and In: 33 to 39% by weight, (IV) Sn: 48 to 52% by weight, Pb: 30 to 34% by weight, and Cd: 16 to 20% by weight, (V) Sn: 44 to 48% by weight, In: 48 to 52% by weight, and Bi: 2 to 6% by weight, (VI) Sn: 44 to 48% by weight, Pb: 28 to 32% by weight, Cd: 14 to 18% by weight, and In: 5 to 9% by weight, and (VII) Sn: 11 to 15% by weight, Pb: 25 to 29% by weight, Bi: 48 to 52% by weight, and Cd: 8 to 12% by weight.

3. DETAILED DESCRIPTION OF THE INVENTION

<TECHNICAL FIELD TO WHICH THE INVENTION PERTAINS>

The present invention relates to an alloy type thermal fuse.

<PRIOR ART>

When an electrical appliance which is to be protected is caused to generate heat by an overcurrent, a thermal fuse operates by the generated heat to interrupt the power supply to the electrical appliance, prevent the electrical appliance from being damaged and consequently prevent a fire from happening, which thermal fuse is broadly divided into an alloy type and a pellet type. In the former alloy type thermal fuse, a low-melting fusible alloy piece to which a flux is applied is used for a fuse element, and the generated heat of an electrical appliance due to an overcurrent blows out the fuse element to interrupt the power supply to the appliance; the operation mechanism is such that a low-melting fusible alloy piece is melted and the molten metal is spheroidized by surface tension thereof while having each lead conductor end as the core, and then the advancement of this spheroidizing divides the molten metal. In this case, the flux performs the function of assuring the above-mentioned spheroid division by preventing surface oxidation of the low-melting fusible alloy piece and solubilizing oxide coating with activity through heating even though the oxide coating exists on a surface of the low-melting fusible alloy piece.

Conventionally, the following have been publicly known

as a fuse element of an alloy type thermal fuse: (I) an Sn-Pb system comprising Pb: 61 to 65% by weight, and Sn: 35 to 39% by weight, (II) an Sn-Pb-Bi system comprising Sn: 16 to 20% by weight, Pb: 30 to 34% by weight, and Bi: 48 to 52% by weight, (III) an Sn-Pb-In system comprising Sn: 46 to 50% by weight, Pb: 13 to 19% by weight, and In: 33 to 39% by weight, (IV) an Sn-Pb-Cd system comprising Sn: 48 to 52% by weight, Pb: 30 to 34% by weight, and Cd: 16 to 20% by weight, (V) an Sn-In-Bi system comprising Sn: 44 to 48% by weight, In: 48 to 52% by weight, and Bi: 2 to 6% by weight, (VI) an Sn-Pb-Cd-In system comprising Sn: 44 to 48% by weight, Pb: 28 to 32% by weight, Cd: 14 to 18% by weight, and In: 5 to 9% by weight, and (VII) an Sn-Pb-Bi-Cd system comprising Sn: 11 to 15% by weight, Pb: 25 to 29% by weight, Bi: 48 to 52% by weight, and Cd: 8 to 12% by weight. In these publicly known elements for the thermal fuse, the solidus temperature and the liquidus temperature agree substantially, and the thermal fuse operates at this liquidus temperature.

<PROBLEMS TO BE SOLVED BY THE INVENTION>

Then, when the fuse element reaches this liquidus temperature, the fuse element in solid phase is melted into liquid phase, and the above-mentioned spheroid division is performed in the liquid phase by surface tension; the fuse element (line) is made into liquid phase from the outer periphery thereof toward the central portion, which is completely made into liquid phase and then the above-mentioned spheroid division is started.

However, in a conventional alloy type thermal fuse employing the above-mentioned alloy as a fuse element, it takes a long time to heat a fuse element surface up to the liquidus temperature and thereafter make it into spheroid division, so that the shortening of the time has been desired.

The object of the present invention is to achieve the shortening of the time required for heating a fuse element surface up to the liquidus temperature and thereafter making it into spheroid division in an alloy type thermal fuse.

<MEANS FOR SOLVING THE PROBLEM>

An alloy type thermal fuse according to the present invention has a construction characterized by using as a fuse element an alloy comprising metal of one, or two or more kinds selected from the group consisting of Cu, Sb, Bi, Cd, In and Ag, except for components of corresponding low-melting alloys, added by 1% by weight or less to one of low-melting alloys of (I) Sn: 61 to 65% by weight, and Pb: 35 to 39% by weight, (II) Sn: 16 to 20% by weight, Pb: 30 to 34% by weight, and Bi: 48 to 52% by weight, (III) Sn: 46 to 50% by weight, Pb: 13 to 19% by weight, and In: 33 to 39% by weight, (IV) Sn: 48 to 52% by weight, Pb: 30 to 34% by weight, and Cd: 16 to 20% by weight, (V) Sn: 44 to 48% by weight, In: 48 to 52% by weight, and Bi: 2 to 6% by weight, (VI) Sn: 44 to 48% by weight, Pb: 28 to 32% by weight, Cd: 14 to 18% by weight, and In: 5 to 9% by weight, and (VII) Sn: 11 to 15% by weight, Pb: 25 to 29% by weight, Bi:

48 to 52% by weight, and Cd: 8 to 12% by weight.

In the present invention, the reason for adding Cu, Sb, Bi, Cd, In, Ag and the like is to cause difference in each of the alloys between the solidus temperature and the liquidus temperature, or increase the difference. The reason for limiting added metal to each of the alloy systems to Cu, Sb, Bi, Cd, In and Ag, and limiting added quantity thereto to 1% by weight or less is to sufficiently retain the liquidus temperature of each of the alloy systems to maintain the operating temperature of each of the alloy system fuse elements.

<FUNCTION>

According to the construction of the present invention, the moment that a fuse element surface reaches the operating temperature, it is at the liquidus temperature, while the temperature at the central portion of the element is between the solidus temperature and the liquidus temperature; the phase state is such that micro-crystals of high-melting components coexist in the melt of low-melting components composing the alloy, so that the strength is extremely low as compared with solid phase. Thus, even though the whole fuse element is not made into liquid phase, the advancement of making into liquid phase to a certain depth ruptures the inner part in the above-mentioned coexistent state than the depth due to surface tension of this liquid phase, whereby the spheroidizing of the molten fuse element is started.

<DESCRIPTION OF EXAMPLES>

The present invention is hereinafter described by referring to drawings.

Fig. 1 is a longitudinal sectional view showing one example of the present invention. In Fig. 1, 1, 1 are a pair of lead wires. 2 is a fuse element bridged between the lead wires by welding. 3 is a flux applied on the fuse element. 4 is an insulation cylinder covering the fuse element, such as a ceramic cylinder. 5, 5 are hardening resin sealing gaps between the insulation cylinder ends and the lead wires, such as epoxy resin.

An alloy is used as the above-mentioned fuse element, which comprises metal of one, or two or more kinds selected from the group consisting of Cu, Sb, Bi, Cd, In and Ag, except for components of corresponding low-melting alloys, added by 1% by weight or less to one of low-melting fusible alloys of (I) Sn: 61 to 65% by weight, and Pb: 35 to 39% by weight, (II) Sn: 16 to 20% by weight, Pb: 30 to 34% by weight, and Bi: 48 to 52% by weight, (III) Sn: 46 to 50% by weight, Pb: 13 to 19% by weight, and In: 33 to 39% by weight, (IV) Sn: 48 to 52% by weight, and Pb: 30 to 34% by weight, (V) Sn: 44 to 48% by weight, In: 48 to 52% by weight, and Bi: 2 to 6% by weight, and (VI) Sn: 44 to 48% by weight, Pb: 28 to 32% by weight, Cd: 14 to 18% by weight, and In: 5 to 9% by weight.

The above-mentioned thermal fuse is used by fitting to an electrical appliance which is to be protected. In this state

of fitting, when the electrical appliance is caused to generate heat by an overcurrent and heated up to the permissible temperature limit, the fuse element surface is made into liquid phase, transformation to the liquid phase is developed toward the inside of the element, and the above-mentioned division due to surface tension is started. In this case, with regard to a thermal fuse according to the present invention, an alloy having difference between the liquidus temperature and the solidus temperature by adding metal of one, or two or more kinds selected from the group consisting of Cu, Sb, Bi, Cd, In and Ag, except for components of corresponding low-melting alloys, is used as the fuse element to have intermediate phase between solid phase and liquid phase; when the fuse element surface is made into liquid phase, the central portion of the fuse element somewhat lower in temperature than the liquidus temperature thereof is in the state of intermediate phase, which is in a state such that micro-crystals coexist in the melt and the strength in this coexistent state is extremely low, so that the fuse element made into liquid phase to a certain depth ruptures the central portion thereof in the above-mentioned coexistent state due to spheroidizing surface tension of the liquid phase to start division before the whole fuse element is made into liquid phase, whereby the current can be interrupted earlier.

Next, various kinds of examples of the present invention are described by contrast with comparative examples.

The type of a thermal fuse used in examples and comparative examples was a linear type shown in Fig. 1, in which the length of a fuse element was 3 mm and the diameter thereof was 0.6 mm, a copper wire having a diameter of 0.5 mm was used for a lead wire, a ceramic cylinder having an inside diameter (diameter) of 1.4 mm and a thickness of 0.3 mm was used for an insulation cylinder, epoxy resin was used for performing sealing, and W•W rosin to which dimethylamine hydrochloride was added by 1% by weight was used for a flux.

Examples 1 to 6

A low-melting fusible alloy (I) of Pb: 37% by weight, and Sn: 63% by weight was used as a base in any of the Examples, and an alloy was used as a fuse element, which comprises Bi, In, Cd, Sb, Cu and Ag in Examples 1 to 6 respectively added by 0.5% by weight each thereto.

Example 7

The above-mentioned low-melting fusible alloy (I) was used as a base, and an alloy was used as a fuse element, which comprises Bi, In, Cd, Sb, Cu and Ag added by 0.1% by weight each thereto.

Comparative Example 1

The above-mentioned low-melting fusible alloy (I) was used as a fuse element.

With regard to the above-mentioned Examples 1 to 7 and Comparative Example 1, when the fuse elements were immersed in an oil bath at a temperature of 188°C to measure the time from

immediately after the immersion to division, the time was 1.5 to 2.0 seconds in any of the Example products, while the time was 4.0 to 4.5 seconds in the Comparative Example product; the time in the Example products was shorter than that in the Comparative Example product.

Examples 8 to 13 and Comparative Example 2

The composition of Pb: 32% by weight, Sn: 18% by weight and Bi: 50% by weight was used as a low-melting fusible alloy, and the quantity (% by weight) of added metal in each of the Examples was as shown in Table 1.

Table 1

Examples \ Added Metals	Cu	Sb	Cd	In	Ag
8	0.5	–	–	–	–
9	–	0.5	–	–	–
10	–	–	0.5	–	–
11	–	–	–	0.5	–
12	–	–	–	–	0.5
13	0.1	0.1	0.1	0.1	0.1

With regard to these Example products and Comparative Example product, when the time from immersion to division was measured under the conditions of an oil bath temperature of 110°C, the time was 5.0 to 8.0 seconds in the Comparative Example product, while the time was 3.0 seconds or less in all of the Example products.

Examples 14 to 19 and Comparative Example 3

The composition of Pb: 16.5% by weight, Sn: 48% by weight and In: 35.5% by weight was used as a low-melting fusible alloy, and the quantity (% by weight) of added metal in each of the Examples was as shown in Table 2.

Table 2

Examples \ Added Metals	Cu	Sb	Bi	Cd	Ag
14	0.5	–	–	–	–
15	–	0.5	–	–	–
16	–	–	0.5	–	–
17	–	–	–	0.5	–
18	–	–	–	–	0.5
19	0.1	0.1	0.1	0.1	0.1

With regard to these Example products and Comparative Example product, when the time from immersion to division was measured under the conditions of an oil bath temperature of 140°C, the time was 4.0 to 7.0 seconds in the Comparative Example product, while the time was 3.0 seconds or less in all of the Example products.

Examples 20 to 25 and Comparative Example 4

The composition of Pb: 32% by weight, Sn: 50% by weight and Cd: 18% by weight was used as a low-melting fusible alloy, and the quantity (% by weight) of added metal in each of the Examples was as shown in Table 3.

Table 3

Examples \ Added Metals	Cu	Sb	Bi	In	Ag
20	0.5	–	–	–	–
21	–	0.5	–	–	–
22	–	–	0.5	–	–
23	–	–	–	0.5	–
24	–	–	–	–	0.5
25	0.1	0.1	0.1	0.1	0.1

With regard to these Example products and Comparative Example product, when the time from immersion to division was measured under the conditions of an oil bath temperature of 160°C, the time was 4.0 to 7.0 seconds in the Comparative Example product, while the time was 3.0 seconds or less in all of the Example products.

Examples 26 to 30 and Comparative Example 4

The composition of Sn: 46% by weight, In: 50% by weight and Bi: 4% by weight was used as a low-melting fusible alloy, and the quantity (% by weight) of added metal in each of the Examples was as shown in Table 4.

Table 4

Examples \ Added Metals	Cu	Sb	Cd	Ag
26	0.5	–	–	–
27	–	0.5	–	–
28	–	–	0.5	–
29	–	–	–	0.5
30	0.1	0.1	0.1	0.1

With regard to these Example products and Comparative

Example product, when the time from immersion to division was measured under the conditions of an oil bath temperature of 120°C, the time was 5.0 to 8.0 seconds in the Comparative Example product, while the time was 3.0 seconds or less in all of the Example products.

Examples 31 to 35 and Comparative Example 5

The composition of Pb: 30% by weight, Sn: 46% by weight, Cd: 16% by weight and In: 7% by weight was used as a low-melting fusible alloy, and the quantity (% by weight) of added metal in each of the Examples was as shown in Table 5.

Table 5

Added Metals / Examples	Cu	Sb	Bi	Ag
31	0.5	-	-	-
32	-	0.5	-	-
33	-	-	0.5	-
34	-	-	-	0.5
35	0.1	0.1	0.1	0.1

With regard to these Example products and Comparative Example product, when the time from immersion to division was measured under the conditions of an oil bath temperature of 140°C, the time was 6.0 to 12.0 seconds in the Comparative Example product, while the time was 4.0 seconds or less in all of the Example products.

Examples 36 to 40 and Comparative Example 6

The composition of Pb: 27% by weight, Sn: 13% by weight,

Cd: 10% by weight and Bi: 50% by weight was used as a low-melting fusible alloy, and the quantity (% by weight) of added metal in each of the Examples was as shown in Table 6.

Table 6

Examples \ Added Metals	Cu	Sb	In	Ag
36	0.5	-	-	-
37	-	0.5	-	-
38	-	-	0.5	-
39	-	-	-	0.5
40	0.1	0.1	0.1	0.1

With regard to these Example products and Comparative Example product, when the time from immersion to division was measured under the conditions of an oil bath temperature of 80°C, the time was 6.0 to 11.0 seconds in the Comparative Example product, while the time was 4.0 seconds or less in all of the Example products.

The applicable scope of the present invention is not limited to the above-mentioned linear type. For example, the following types can be used: as shown in Fig. 2, a fuse element 2 is bridged by welding between the tips of a pair of parallel lead wires 1, 1 to apply a flux 3 on the fuse element, which is covered with an insulation case 4 with one end opened to seal gaps between one-end opening 41 of the case 4 and the lead wires 1, 1 with hardening resin 5; as shown in Fig. 3, a fuse element 2 is bridged by welding between the tips of a pair of parallel

lead wires 1, 1 to apply a flux 3 on the fuse element and dipcoat the outside thereof with hardening resin 5; or as shown in Fig. 4, a pair of film electrodes 7, 7 are placed on one side of a heat-resistant insulation substrate 6 to solder lead wires 1, 1 to each of the electrodes 7, 7, between which a fuse element 2 is bridged by welding to apply a flux 3 on the fuse element and moldcoat one side of the insulation substrate with hardening resin 5.

<EFFECT OF THE INVENTION>

An alloy type thermal fuse according to the present invention has a construction as described above, in which a fuse element having approximately uniform liquidus temperature and difference between this liquidus temperature and the solidus temperature is used in contrast to a conventional fuse element, so that the element can be divided at a stage of the advancement of making into liquid phase to a certain depth from the element surface before the whole fuse element is not made into liquid phase, whereby the fuse element can be divided earlier. Therefore, the current interrupting speed of the thermal fuse can be so heightened that the degree of damage in an appliance which is to be protected can be kept slight.

4. BRIEF DESCRIPTION OF DRAWINGS

Figs. 1 to 4 are each explanatory views showing examples of the present invention.

2 fuse element

JP 3-236130

Fig. 1

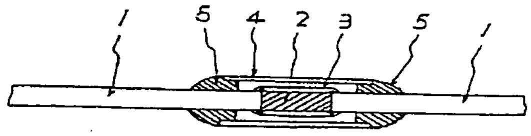

Fig. 2

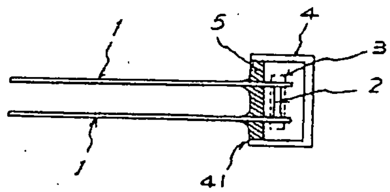

Fig. 3

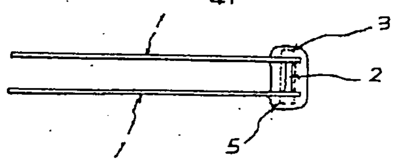

Fig. 4